XERIC HARDPAN FOREST (BASIC HARDPAN SUBTYPE)

Concept: Xeric Hardpan Forests are woodlands with open vegetation because of restricted rooting depth caused by dense or shrink-swell clay. Surface or shallow rock may be present but is limited in extent and is not the primary cause of openness. The vegetation is an open woodland or savanna dominated by *Quercus stellata*, with or without *Pinus echinata, Quercus marilandica,* or *Carya carolinae-septentrionalis*. It may contain other drought-tolerant species but has little *Quercus alba* or more mesophytic tree presence. The vegetation flora of these communities indicates a drier environment than that of Dry Oak–Hickory Forest and the trees are often somewhat stunted. Canopy density is less than in dry forests and depends more on fire and disturbance history.

The Basic Hardpan Subtype covers examples on upland flats developed over mafic rocks, where acid-loving flora such as *Vaccinium* is absent or scarce and some basic indicator species are present.

Distinguishing Features: Xeric Hardpan Forests are distinguished from Dry Oak–Hickory Forest and Dry Basic Oak–Hickory Forest by having a canopy of more xerophytic composition, with *Quercus stellata* dominant or codominant. *Pinus echinata, Carya carolinae-septentrionalis,* or *Quercus marilandica* may codominate, but *Quercus alba* and more mesic oaks are uncommon. Fire-suppressed, degraded examples of Piedmont Longleaf Pine Forest may be dominated by *Quercus stellata* and other xerophytic species, but they will not occur on flat hardpan soils or rocky mafic ridges, will generally have evidence of the past presence of *Pinus palustris* and its associates, and will have a flora with more Coastal Plain affinities. Xeric Hardpan Forests are distinguished from Montane Red Cedar–Hardwood Woodland and other rock-outcrop-related woodlands by clayey soils and the absence of characteristic rock outcrop flora. Piedmont Basic Glades may share some species but occur on slopes and are associated with shallow soils and rock.

The Basic Hardpan Subtype is distinguished from the Northern and Southern Prairie Barren Subtypes by a more limited component of the characteristic flora of prairie affinities (see the Prairie Barren Subtype for this flora), though widespread prairie species such as *Schizachyrium scoparium* should be present. Given the pervasive alteration of these communities, geography and flora evident in nearby open areas may need to be used. Both Prairie Barren subtypes have a narrow geographic range and are associated with a large number of rare species in roadsides, corridors, and pastures. The Basic Hardpan Subtype is distinguished from the Basic Rocky Subtype by occurrence on broad upland flats, generally without rock outcrops, rather than on bouldery ridge tops or steep slopes. No plants are known to be exclusive to the Basic Rocky Subtype, but *Carya carolinae-septentrionalis* and *Acer leucoderme* generally are much more abundant there. No frequent species are known to be exclusive to the Basic Hardpan Subtype, though *Clematis ochroleuca* may be primarily in it. *Quercus phellos* or other species typical of wetter conditions are generally present in small numbers in the Basic Hardpan Subtype.

The Basic Hardpan Subtype is distinguished from the Acidic Hardpan Subtype by a flora indicative of mafic substrate influence in the soil. Acid-loving flora such as *Chimaphila maculata, Vaccinium* species (other than *V. arboreum* and some *V. stamineum*), *Gaylussacia* spp., and *Oxydendrum arboreum* are absent or scarce. More base-loving flora such as *Clematis ochroleuca, Viburnum*

spp., *Symphoricarpos orbiculatus, Rhus aromatica, Cercis canadensis, Fraxinus americana,* and *Ulmus alata* are usually common.

Synonyms: *Quercus stellata - Carya (carolinae-septentrionalis, glabra) - (Quercus marilandica) / Ulmus alata / (Schizachyrium scoparium, Piptochaetium avenaceum)* Woodland (CEGL003714). Ecological Systems: Piedmont Hardpan Woodland and Forest (CES202.268).

Sites: Xeric Hardpan Forest (Basic Hardpan Subtype) occurs on broad upland ridgetops or flats underlain by diabase, gabbro, amphibolite, or other mafic rocks. The sites are often unusually flat, with more subdued topography than typical Piedmont uplands. Such flat areas are commonly associated with mafic rocks.

Soils: Soils of the Basic Hardpan Subtype are generally mapped as Alfisols. Iredell (Vertic Hapludalf) is the most common mapped. Picture (Vertic Argiaquoll), a more recently defined series might be applied to more if sites were reexamined. Some examples are mapped as Enon (Ultic Hapludalf), a few as Helena (Aquic Hapludult) or other Ultisols. These soils have montmorillonite as the primary clay mineral; the vertic properties of these soils, shrinking and swelling in response to changing water content, is an important characteristic even though no true Vertisols have been identified in North Carolina. Damage to fine roots combines with impermeability of the clay pan to restrict rooting depth and create xeric conditions for plants.

Hydrology: Xeric Hardpan Forests are xerohydric but with a predominance of xeric conditions. The soils are drier than is typical in the driest Piedmont sites because of restricted water penetration. However, they may perch water and even pond water locally after heavy rains.

Vegetation: The vegetation in the least altered remaining examples is an open forest or woodland dominated by *Quercus stellata*, often with *Pinus echinata*, *Carya carolinae-septentrionalis, Carya glabra*, or *Ulmus alata* abundant. *Quercus marilandica* may be present. *Quercus alba* and *Carya tomentosa* may be present in small amounts. In more altered examples, *Pinus virginiana, Pinus taeda*, or other species may be abundant. Under more natural conditions, *Quercus stellata, Pinus echinata*, and *Quercus marilandica* are likely to be more dominant, the other species less so. The understory often is dominated by *Juniperus virginiana* or *Ulmus alata*, and often contains *Diospyros virginiana, Cercis canadensis, Chionanthus virginicus*, and *Cornus florida*. The shrub layer consists primarily of tree saplings, but may include abundant *Viburnum prunifolium, Rhus aromatica, Rosa carolina,* or *Symphoricarpos orbiculatus*. Vines, including *Parthenocissus quinquefolia, Smilax bona-nox, Smilax rotundifolia, Toxicodendron radicans*, and *Muscadinia rotundifolia* are frequent though not usually dense. Under more natural conditions, these lower woody strata would be sparse, though the same species might be present. The herb layer generally is sparse to moderate in density in known examples. *Danthonia spicata* is the most frequent species, and *Piptochaetium avenaceum* or *Scleria oligantha* sometimes dominate patches. Frequent herbs in CVS plot data include *Dichanthelium boscii, Galium circaezans, Asplenium platyneuron, Dichanthelium laxiflorum*, and *Endodeca serpentaria*. Also fairly frequent are *Galium pilosum, Antennaria plantaginea Potentilla canadensis, Polygonatum biflorum, Ruellia carolinensis*, and *Scutellaria integrifolia*. Less frequent but characteristic species in plot data or noted in literature (Batson 1952, Oosting 1942, Peet and Christensen 1980) and site reports include *Clematis ochroleuca, Sericocarpus linifolius, Coreopsis major, Lespedeza virginica, Physalis*

virginiana, Manfreda virginica, Symphyotrichum undulatum, Symphyotrichum dumosum, Stylosanthes biflora, Pycnanthemum tenuifolium, Desmodium paniculatum, Parthenium integrifolium, Oenothera fruticosa, Tragia urticifolia, Ruellia purshiana, and a number of species of *Carex*. Under more natural conditions of frequent fire and more open canopy, the herb layer is expected to be dense and more diverse. *Schizachyrium scoparium* is likely to be dominant or codominant. Though rarely found now, many of the suite of fire-tolerant herbs of open woodland might also be present, including *Solidago odora, Tephrosia virginiana, Baptisia tinctoria, Liatris squarrosa, Lespedeza procumbens, Andropogon gerardii, Sorghastrum nutans, Pityopsis graminifolia, Ionactis linariifolia, Sericocarpus asteroides,* and *Hypoxis hirsuta*.

Range and Abundance: Ranked G2G3. This community is scattered throughout the lower and middle Piedmont. This community ranges from Virginia to Georgia.

Associations and Patterns: All remaining occurrences are small patches but some may originally have been large patches. They are usually naturally associated with Dry Basic Oak–Hickory Forest and often with Upland Depression Swamp Forest. Piedmont Headwater Stream Forest (Hardpan Subtype) bands may form or run through them.

Variation: No variants are defined. The formerly recognized variants are now treated as subtypes.

Dynamics: Dynamics are similar to most of the Piedmont barrens. Open canopy structure is maintained by dry soil conditions but the natural fire regime would produce a much more open canopy and understory than is seen at present. Because these communities occur as small to large patches, fires would primarily spread from the surrounding landscape, so fire frequency must largely match that of the prevailing oak forests. However, because of the extreme site conditions, the effects of this fire frequency would be greater and would maintain a more open woodland structure. With a denser grass-dominated herb layer, burning would be more complete and fire somewhat more intense than in the current hardwood litter. Fires would probably not be hot enough to harm mature oak or pine trees but would top-kill seedlings and saplings. Most sensitive plant species would be excluded. The existence of old oaks and pines in some remaining sites suggests that these communities existed as open savannas or woodlands rather than as treeless prairies, though later clearing and increased fire frequency after settlement may have left some treeless. See additional discussion under the Northern and Southern Prairie Barren subtypes.

Under natural conditions of open canopy and frequent fire, tree regeneration would be less dependent on canopy gaps and more on favorable fire intervals than in the present forests or in the surrounding oak-hickory forests.

Historical references (e.g., Logan 1859) describe extensive prairies and open, grassy woodlands in the vicinity of Rock Hill, South Carolina, where Iredell soils are common. They note that such areas had later grown up in blackjack. That area likely represented the Southern Prairie Barren Subtype but some may have been the Basic Hardpan Subtype.

Comments: Though Xeric Hardpan Forests make up only a small portion of the landscape in most parts of the Piedmont, their distinct vegetation and its relationship to dense clay soils, restricted rooting depth, mafic rocks, and the Iredell soil series has long been recognized. Oosting (1942)

called them preclimax forests, maintained indefinitely in less than climax condition by the extreme soils. Peet and Christensen (1980) found what they called montmorillonite forests to be a distinctive vegetation group, separating from oak-hickory forest communities at the highest level of their progressive ordinations. Dayton's (1965) study of vegetation of Iredell soils in Granville County likely included both the Basic Hardpan Subtype and Northern Prairie Barren Subtype. The same vegetation is described as distinctive in Wharton (1977) in Georgia.

While early descriptions are recognizable as the Xeric Hardpan Forests we see today, these descriptions hint at continued change in vegetation with the removal of fire, even in recent decades. *Quercus marilandica* is usually mentioned prominently, often described as abundant and sometimes used in the naming of the vegetation. Present examples often have none and never have much of this species. *Symphyotrichum dumosum* was frequently mentioned, yet only 2 out of 48 plots of this community in three states have any of it. *Oenothera fruticosa, Sericocarpus linifolius, Stylosanthes biflora*, and species of *Liatris* are additional species that are mentioned as characteristic by Oosting (1942) and other earlier studies but which have very low frequency in recent plot data and site descriptions alike.

The relationship between the Basic Hardpan Subtype and the Northern and Southern Prairie Barren subtypes needs further clarification. All occur on similar flat montmorillonitic hardpan soils and all can look similar in altered remnants. The two Prairie Barren subtypes are recognized for the two areas where hardpan soils are extensive and where remaining open areas have a much more diverse flora of prairie affinities. The distinction is presumed to be a biogeographic one – the large areas have an extensive pool of species of open woodlands or prairies while naturally small patches have a limited pool. However, it is unclear how many species of open conditions may have been lost in small patches as they became dense. There likely was a difference in dynamic processes as well. Large areas of Xeric Hardpan Forest likely increased fire frequency and intensity to some degree, and this could contribute to the more diverse prairie flora and perhaps to more open vegetation.

Rare species:
Vascular Plants: *Acmispon helleri, Berberis canadensis, Echinacea laevigata, Helianthus schweinitzii, Solidago rigida ssp. glabrata,* and *Symphyotrichum georgianum*.

References:
Barden, L.S. 1997. Historic prairies of the Piedmont of North and South Carolina, USA. Natural Areas Journal 17: 149-152.

Batson, W.T. 1952. The floristics of the Iredell Soil Series in the central Piedmont of North Carolina. Ph.D. Dissertation, Duke University.

Dayton, B.R. 1965. The relationship of Iredell and other Piedmont soils in Granville County, North Carolina. Journal of the Elisha Mitchell Scientific Society 82: 108-118.

Logan, J.H. 1859. A history of the upper country of South Carolina from the earliest periods to the close of the War of Independence. Vol. 1. Courtnay and Company, Charleston, SC.

Oosting, H.J. 1942. An ecological analysis of the plant communities of Piedmont, N.C. Am. Midl. Nat. 28: 1-126.

Peet, R.K., and N.L. Christensen. 1980. Hardwood forest vegetation of the North Carolina Piedmont. Veroeff. Geobot. Inst. ETH, Stiftung Rubel, Zurich. 69. Heft: 14-39.

Wharton C.H. 1977. The natural environments of Georgia. Georgia Dept. of Natural Resources, Office of Planning and Research, Resource Planning Section. 1977 (tDAR id: 64311)